AMENDMENTS TO THE SPECIFICATION

Please amend the paragraph on page 1, line 14, to page 2, line 7, as follows:

FIG. 30 shows the general construction of a conventional plating apparatus for plating copper or the like on a semiconductor substrate. As shown in FIG. 30, the conventional substrate plating apparatus is provided with a plating tank 411 that holds a plating liquid Q, and arranges a substrate W, such as a semiconductor wafer, and an anode 412 opposing each other therein. A plating power source 413 is connected to the substrate W and the anode 412. When the plating power source 413 applies a prescribed voltage thereacross, a current containing ions dissolved from the copper plate or the like serving as the anode 412 flows toward the surface (processing surface to be plated) of the substrate W and forms a plated copper film thereon. The substrate W is ~~etachably~~ detachably held by a substrate holder 414. When the current flows between the anode 412, which is formed of copper containing phosphorus, for example, and the substrate W, the ionized copper is conveyed by the plating current and deposited on the surface of the substrate W to form a plated film. The plating liquid Q overflowing the wall 415 of the plating tank 411 is collected in a recovery tank 416. The plating liquid Q in the recovery tank 416 is reintroduced to the plating tank 411 through a plating liquid circulation system comprising a pump 420, a temperature regulating tank 421, a filter 422, ~~and~~ a flow meter 423 and so on.

Please amend the paragraph on page 2, line 14, to line 25, as follows:

In order to prevent such plating defects or incomplete plating, ~~it has been~~ conventionally ~~conducted to lower~~ the surface tension of a plating liquid has been lowered by adding a surfactant thereto, thereby facilitating entering of the plating liquid into the fine trenches and plugs for interconnects of the substrate to be plated, or the openings of a resist. However, air bubbles tend to generate more easily in a plating liquid during circulation when the surface tension of the plating liquid is low. Further, the addition of a surfactant to the plating liquid can cause an abnormal plating deposition and increase the amount of an organic substance taken in the plated film, leading to lowering of the properties of the plated film.

Please amend the paragraph on page 2, line 26, to page 3, line 10, as follows:

In a tape automated bonding (TAB) or flip chip, for example, it has been widely conducted to deposit gold, copper, solder, nickel or multi-layered materials thereof at prescribed areas (electrodes) on the surface of a semiconductor chip having interconnects, thereby forming protruding connecting electrodes (bumps). Such bumps electrically connect the semicondcutor chip with substrate electrodes or TAB electrodes. There are various methods for forming these bumps, including an electrolytic plating method, vapor deposition method, printing method, and ball bump method. The electrolytic plating method has become ~~in~~ wide in use due to its relatively stable performance and capability of forming fine connections, in view of the recent tendency ~~to~~ toward increasing the number of I/O terminals on semiconductor chips and ~~to~~ toward finer pitch.

Please amend the paragraph on page 3, line 11, to line 24, as follows:

The electrolytic plating method includes a spurting or cup method in which a substrate such as a semicondcutor wafer is positioned horizontally with the processing surface to be plated facedown and a plating liquid is spurted from below; and a dipping method in which the substrate is placed vertically in a plating tank and immersed in a plating liquid, while a plating liquid is supplied from the bottom of the plating tank and is allowed to overflow the tank. According to the dipping method of electrolytic plating, bubbles that can adversely affect the quality of the plating are easily removed and the footprint is small. Further, the dipping method can be readily adapted to variations in wafer size. The dipping method is therefore considered to be suited for bump plating in which holes to be ~~filling~~ filled by the platng are relatively large and which requires a fairly long plating time.

Please amend the paragraph on page 3, line 25, to page 4, line 9, as follows:

When forming bumps at prescribed areas of a substrate having interconnects, a seed layer 500 as an electric feed layer is first formed on the surface of the substrate W, as shown in FIG. 29A. A resist 502 having a height H of e.g. 20-120 μm is applied to the entire surface of the seed layer 500. An opening 502a having a diameter D of e.g. 20-200 μm is formed in a prescribed portion of the resist 502. Plating is performed onto such a surface of the substrate W to deposit and grow a plated

film 504 in the opening 502a, thereby forming a bump 506 (see FIGS. 29B-29E). When using the facedown-type electrolytic plating to form the bump 506, air bubbles 508 generated in the plating liquid are likely to remain ~~in~~ on the inside of the opening 502a, as shown by the dotted line in FIG. 29A, particularly when the resist 502 is hydrophobic.

Please amend the paragraph on page 5, line 9, to line 20, as follows:

A first embodiment of a plating apparatus according to the present invention comprises: a substrate holder capable of opening and closing for holding a substrate such that the front surface of the substrate is exposed while the back side and the edge thereof are hermetically sealed; ~~a.~~ A plating tank ~~for holding~~ holds a plating liquid in which an anode is immersed; ~~a.~~ A diaphragm is provided in the plating tank and disposed between the anode and the substrate held by the substrate holder; ~~plating.~~ Plating liquid circulating systems ~~for circulating~~ circulate the plating liquid through ~~the~~ respective regions of the plating tank, partitioned by the diaphragm; ~~and a.~~ A deaerating unit is provided in at least one of the plating liquid circulating systems.

Please amend the paragraph on page 6, line 19, to line 25, as follows:

A plating method according to the present invention, ~~comprising:~~ comprises providing a diaphragm between a substrate and an anode immersed in a plating liquid held in a plating tank;, circulating the plating liquid in each region of the plating tank partitioned by the diaphragm; and plating the substrate while maintaining the concentration of dissolved oxygen in the plating liquid between 1 μg/l (1 ppb) and 4 mg/l (4 ppm) by a deaerating unit.

Please amend the paragraph on page 6, line 26, to page 7, line 14, as follows:

A second embodiment of a plating apparatus according to the present invention; comprises: a cassette table for loading a cassette housing a substrate therein; ~~a.~~ A substrate holder is capable of opening and closing for holding the substrate such that the front surface of the substrate is exposed while the back side and the edge thereof are hermetically sealed; ~~a.~~ A substrate loading/unloading unit ~~for supporting~~ supports the substrate holder, and ~~loading~~ loads and ~~unloading~~ unloads the

substrate~~; a.~~ A substrate transferring device ~~for transferring~~ transfers the substrate between the cassette table and the substrate loading/unloading unit~~; a.~~ A plating tank ~~for accommodating~~ accommodates the substrate holder and the substrate, held vertically and facing ~~to~~ toward an anode, and ~~plating~~ plates the surface of the substrate by injecting a plating liquid from the bottom thereof~~; and a.~~ A substrate holder tansferring device ~~having~~ has a transporter that grips the substrate holder and is vertically moveable, and transfers the substrate holder between the substrate loading/unloading unit and the plating tank.

Please amend the paragraph on page 8, line 28, to page 9, line 6, as follows:

A stocker for storing the substrate holder in a vertical position may be provided between the substrate loading/unloading unit and the plating tank; and the substrate holder transferring device may have first and second transporters. By performing transferring operations with separate transporters, the substrate holder can be transferred more smoothly, thereby increasing throughput.

Please amend the paragraph on page 9, line 7, to line 18, as follows:

The substrate loading/unloading unit may preferably be provided with a sensor for checking the contact state between the substrate and contact points when the substrate is loaded into the substrate holder~~; and the~~. The second transporter selectively transfers only such substrate that has a good contact with the contact points to a subsequent process. With this construction, the plating operation need not be halted, but is allowed ~~allows~~ to ~~be continuing~~ continue, if a poor contact is detected between the substrate and contact points when the substrate is loaded into the substrate holder. The substrate in which the poor contact is detected ~~does~~ is not ~~apply~~ applied to the plating process, but instead is discharged from the cassette after being returned thereto.

Please amend the paragraph on page 9, line 25, to page 10, line 10, as follows:

The plating apparatus may further comprises a pre-wetting tank, blowing tank, and cleaning tank between the stocker and the plating tank. With this construction, it is possible to perform a series of processes in the same apparatus, such as immersing the substrate in pure water

held in the pre-wetting tank to wet the surface of the substrate and improve its hydrophilic properties, performing the plating operation, thereafter cleaning the substrate in pure water in the cleaning tank, and drying the substrate in the blowing tank. When performing a plating process using solder, copper or other metals that can be oxidized to form an oxide film, the substrate should be placed in a pre-soaking tank after the pre-wetting tank, wherein the oxide film on the seed layer is removed through chemical etching before performing the plating operation

Please amend the paragraph on page 10, line 17, to line 28, as follows:

A first embodiment of a plating apparatus for forming a protruding electrode according to the present invention concerns an apparatus for forming a protruding electrode on a substrate having wiring formed thereon, comprising: a cassette table for loading a cassette housing the substrate therein; ~~a.~~ A plating tank ~~for plating~~ plates the substrate; ~~a.~~ A cleaning unit ~~for cleaning~~ cleans the plated substrate; ~~a.~~ A drying unit ~~for drying~~ dries the cleaned substrate; ~~a.~~ A deaerating unit ~~for deaerating~~ deaerates a plating liquid in the plating tank; ~~a.~~ A plating liquid regulating unit ~~for analyzing~~ analyzes the components of the plating liquid and ~~adding~~ adds components to the plating liquid based on the results of the analysis; ~~and a.~~ A substrate transferring device ~~for transferring~~ transfers the substrate.

Please amend the paragraph on page 11, line 1, to line 12, as follows:

A second embodiment of a plating apparatus for forming a protruding electrode according to the present invention concerns an apparatus for forming a protruding electrode on a substrate having wiring formed ~~thereron~~ thereon, comprising: a cassette table for loading a cassette housing the substrate therein; ~~a.~~ A pre-wetting tank ~~for applying~~ applies a pre-wetting treatment to the substrate to increase the wettability thereof; ~~a.~~ A plating tank ~~for plating~~ plates the substrate after the pre-wetting treatment; ~~a.~~ A cleaning unit ~~for cleaning~~ cleans the plated substrate; ~~a.~~ A drying unit ~~for drying~~ dries the cleaned substrate; ~~a.~~ A deaerating unit ~~for deaerating~~ deaerates a plating liquid in the plating tank; and a substrate transferring device ~~for transferring~~ transfers the substrate.

Please amend the paragraph on page 11, line 13, to line 23, as follows:

A third embodiment of a plating apparatus for forming a protruding electrode according to the present invention concerns an apparatus for forming a protruding electrode on a substrate having wiring formed thereon, comprising: a cassette table for loading a cassette housing the substrate therein; ~~a.~~ A pre-soaking tank ~~for applying~~ applies a pre-soaking treatment to the substrate; ~~a.~~ A plating tank ~~for plating~~ plates the substrate after the pre-soaking treatment; ~~a.~~ A cleaning unit ~~for cleaning~~ cleans the plated substrate; ~~a.~~ A drying unit ~~for drying~~ dries the cleaned substrates; ~~a.~~ A deaerating unit ~~for deaerating~~ deaerates the plating liquid in the plating tank; and a substrate transferring device ~~for transferring~~ transfers the substrates.

Please amend the paragraph on page 11, line 24, to page 12, line 3, as follows:

A fourth embodiment of a plating apparatus for forming a protruding electrode according to the present invention concerns an apparatus for forming a protruding electrode on a substrate by plating the substrate with at least two kinds of metals, comprising: a plurality of plating tanks each for plating the substrate with each of the above metals; ~~and a.~~ A substrate transferring device ~~for transferring~~ transfers the substrate, wherein the plating tanks are disposed along a transferring path of the substrate transferring device.

Please amend the paragraph on page 12, line 4, to line 13, as follows:

A fifth embodiment of a plating apparatus for forming a protruding electrode according to the present invention concerns an apparatus for forming a protruding electrode on a substrate having wiring formed thereon, comprising: a cassette table for loading a substrate cassette thereon; ~~a.~~ A plating tank ~~for plating~~ plates the substrate; ~~a.~~ A cleaning unit ~~for cleaning~~ cleans the plated substrate; ~~a.~~ A drying unit ~~for drying~~ dries the cleaned substrate; ~~a.~~ A deaerating unit ~~for deaerating~~ deaerates a plating liquid in the plating tank; ~~an.~~ An annealing unit ~~for annealing~~ anneals the plated substrate; and a substrate transferring device ~~for transferring~~ transfers the substrate.

Please amend the paragraph on page 12, line 14, to line 23, as follows:

A first embodiment of a plating method for forming protruding electrodes according to the present invention concerns a method for forming a protruding electrode on a substrate having wiring formed thereon, comprising: holding a substrate taken out of a cassette by a substrate holder;, pre-wetting the substrate held by the substrate holder;, plating the pre-wetted surface of the substrate by immersing the substrate together with the substrate holder in a plating liquid;, cleaning and drying the plated substrate together with the substrate holder;, and taking the substrate out of the substrate holder and drying the substrate.

Please amend the paragraph on page 12, line 24, to page 13, line 5, as follows:

A second embodiment of a plating method for forming a protruding electrode according to the present invention concerns a method for forming a protruding electrode on a substrate having wiring formed thereon, comprising: holding a substrate taken out of a cassette by a substrate holder;, pre-soaking the substrate held by the substrate holder;, plating the pre-soaked surface of the substrate by immersing the substrate together with the substrate holder in a plating liquid;, cleaning and drying the substrate together with the substrate holder; and taking the substrate out of the substrate holder and drying the substrate.

Please amend the paragraph on page 13, line 25, to line 26, as follows:

FIG. 6 is an enlarged cross-sectional view of ~~the~~ a relevant portion of FIG. 5 in terms of a supply of electricity to the substrate;

Please amend the paragraph on page 14, line 3, to line 4, as follows:

FIG. 10 is a plan view showing ~~the~~ an arm rotating mechanism of the transporter with the phantom line;

Please amend the paragraph on page 15, line 21, to page 16, line 9, as follows:

Preferred embodiments of a plating apparatus according to the present invention will be described with reference to FIGS. 1 through 28. FIG. 1 shows the construction of a plating apparatus according to a first embodiment of the present invention. As shown in FIG. 1, the plating apparatus includes a cation exchange membrane 318 as a diaphragm which is disposed between a cathode (substrate W) and an anode 312 connected to a plating power source 313. The cation exchange membrane (diaphragm) 318 partitioned the space in the plating tank 311 into two regions T_1 including the substrate W and T_2 including the anode 312. The plating apparatus of this embodiment is a copper-plating apparatus designed to form a plated copper film on the surface (processing surface to be plated) of the substrate W. The anode 312 is a soluble anode and a plating liquid Q is a copper sulfate solution. The substrate W, which is detachably held by the substrate holder 314 with a watertight seal being made over the backside of the substrate W, is ~~immerse~~ immersed in the plating liquid Q.

Please amend the paragraph on page 17, line 2, to line 15, as follows:

A first plating liquid circulation system C_1, which circulates the plating liquid Q, which overflows the wall 315 of the plating tank 311 and collects in the recovery tank 316, back to the region T_1 on the substrate W side of the plating tank 311, is provided on the substrate W side of the plating tank 311. The first plating liquid circulation system C_1 includes a vacuum pump 320 that circulates the plating liquid Q through a temperature regulating unit 321, a filter 322, a deaerator (deaerating unit) 328, a dissolved oxygen concentration measuring unit 340, and a flow meter 323. The temperature regulating unit 321 stabilizes the growth rate of the plated film by maintaining the plating liquid Q at a prescribed temperature. The filter 322 removes particles from the plating liquid Q before the plating liquid Q is reintroduced into the plating tank 311.

Please amend the paragraph on page 17, line 16, to page 18, line 10, as follows:

The deaerator 328 removes dissolved gases from the plating liquid Q flowing through the first plating liquid circulation system C_1. The deaerator 328 is provided with a vacuum pump 329

for removing various dissolved gases, including oxygen, air, ~~and~~ carbon dioxide and the like, from the plating liquid Q flowing through the circulation system, using a membrane which allows only gases to pass therethrough, while preventing the passage of liquid. The vacuum pump 329 removes dissolved gases from the plating liquid by drawing the gases through the membrane in the deaerator 328. The dissolved oxygen concentration measuring unit 340 is provided in the first plating liquid circulation system C_1 to monitor the concentration of dissolved oxygen in the plating liquid circulating through the first plating liquid circulation system C_1. Based on the results of the measurements, it is possible to regulate the pressure on the decompressed side of the deaerator 328 using a control unit (not shown) for controlling the rotational speed of the vacuum pump 329 or the like. With this method, it is possible to regulate the dissolved gases in the plating liquid at a desired concentration. It is desirable to maintain the concentration of dissolved oxygen between approximately 1 μg/l (1 ppb) and 4 mg/l (4 ppm). With this concentration, it is possible to eliminate bubbles dissolved in the plating liquid nearly ~~into~~ to zero, thereby forming a satisfactory plated film.

Please amend the paragraph on page , line , to page , line , as follows:

FIG. 2 shows a plating apparatus according to a second embodiment of the present invention. In this embodiment, the second plating liquid circulation system C_2 disposed on the anode 312 side of the plating tank 311 partitioned by the cation exchange membrane 318 is further provided with the deaerator (deaerating ~~divice~~ device) 328 and dissolved oxygen concentration measuring unit 340. Accordingly, the plating liquid Q is deaerated while being circulated to both the regions T_1 on the substrate W (anode) side and T_2 on the anode 312 side partitioned by the cation exchange membrane 318. Therefore, it is possible to further reduce the amount of gas bubbles in the plating liquid compared to the first embodiment shown in FIG. 1.

Please amend the paragraph on page 23, line 17, to page 24, line 2, as follows:

As shown in FIGS. 4 through 6, the substrate holder 18 includes a flat, rectangular shaped fixed supporting member 54, and a ring-shaped moveable supporting member 58 mounted on the

fixed supporting member 54 and capable of opening and closing over the fixed supporting member 54 through a hinge 56. A ring-like seal packing 60, having a rectangular cross-section with an open bottom with one of the parallel sides longer than the other, is mounted at the fixed supporting ~~menber54~~ member 54 side of the moveable supporting member 58 through a packing base 59 made of vinyl chloride, serving as a reinforcing member and having a good lubrication with a clamp ring 62 . The clamp ring 62 is held on the fixed supporting ~~menber54~~ member 54 via bolts 64 passing through a plurality of long holes 62a formed along the circumference of the clamp ring 62 so as to be rotatable and not be removed from the fixed supporting member 54.

Please amend the paragraph on page 31, line 23, to page 32, line 7, as follows:

A plating liquid regulating unit 610 is further provided in a branch off the plating liquid circulation system C_3 for analyzing the plating liquid while one-tenth of the overall plating liquid, for example, is ~~extracting~~ extracted. Based on the analysis results, components that are lacking in the plating liquid are added to the plating liquid. The plating liquid regulating unit 610 includes a plating liquid regulating tank 612 in which components lacking in the solution are added. A temperature controller 614 and a plating liquid analyzing unit 616 for extracting and analyzing a sample of plating liquid are disposed adjacent to the plating liquid regulating tank 612. The plating liquid returns from the plating liquid regulating tank 612 to the plating liquid circulation system C_3 through a filter 620 by the operation of a pump 618.

Please amend the paragraph on page 34, line 19, to page 35, line 3, as follows:

As shown in FIG. 19, the plating liquid supply pipes 206 are opened inside the plating units 38 at the bottom of them. A regulating plate 210 is mounted at the open end of the plating liquid supply pipe 206. The plating liquid is injected through the regulating plate 210 into the plating unit 38. A waste solution pipe 212 is attached at one open end to the plating unit 38 and positioned around the plating liquid supply pipe 206, while the other end of the waste solution pipe 212 is connected to the plating liquid discharge pipe 208 through an elbow pipe 214. With this configuration, the plating liquid near the plating liquid supply pipe 206 is discharged through the

waste solution pipe 212 and plating liquid discharge pipe 208, ~~and prevented~~ preventing the plating liquid from being stagnant at this point.

Please amend the paragraph on page 38, line 1, to line 10, as follows:

Next, the gripping mechanisms 108 of the transporter 42 of the substrate holder transferring device 40 grip both of the substrate holders 18 holding the substrate simultaneously, and the arm raising/lowering mechanism 104 raises the arm 102. After transferring the substrate holders 18 to the stocker 24, the arm rotating mechanism 106 rotates the arm 102 by ~~90°—~~, 90°, such that the substrate holders 18 are positioned vertically. The arm raising/lowering mechanism 104 lowers the arm 102, thereby suspending (~~temporarily~~ temporary placement) the two substrate holders 18 in the stocker 24.

Please amend the paragraph on page 38, line 22, to page 39, line 8, as follows:

Meanwhile, the gripping mechanisms 108 of the other transporter 44 of the substrate transferring device 40 simultaneously grip two substrate holders 18 that have been holding the substrates and temporarily placed in the stocker 24. The arm raising/lowering mechanism 104 of the transporter 44 raises the arm 102 and the transporter 44 transfers the substrate holders 18 to the pre-wetting tank 26. The arm raising/lowering mechanism 104 lowers the arm 102, thereby immersing ~~the~~ both the substrate holders 18 into pure water, for example, held in the pre-wetting tank 26. The pure water wets the surfaces of the substrates W to create a more hydrophilic surface. Obviously, an aqueous liquid other than pure water can be used, providing the liquid can improve the hydrophilic property of the substrate by wetting the surface of the substrate and replacing the bubbles in the holes with water.

Please amend the paragraph on page 40, line 8, to line 19, as follows:

When ~~the~~ all the substrate holders 18 are suspended in the plating units 38, plating liquid is supplied through the plating liquid supply pipes 206. While the plating liquid overflows into the overflow tank 36, plating voltages are applied between the anodes 200 and the substrates. At the

same time, the paddle driving units 46 reciprocate the paddles 202 in a direction parallel to the surfaces of the substrates, thereby plating the surfaces of the substrates. At this time, each of the substrate holders 18 is fixed in a suspended state by the hands 76 at the top of the plating unit 38. Electricity is supplied from a plating power source to the seed layer on the substrate via the hand fixed portion, the hand, and the contact points.

Please amend the paragraph on page 40, line 20, to page 41, line 1, as follows:

The plating liquid is injected into the plating units 38 through the bottom thereof and overflows into the top of the walls around the plating units 38. The overflowed plating liquid is regulated ~~of~~ in its concentration, and ~~removed of~~ has foreign ~~body~~ bodies removed by the filter before being reintroduced into the plating units 38 from the lower portion of the plating units 38. With this circulation process, the concentration of the plating liquid is maintained at a constant level. The plating liquid can be maintained at an even more uniform state by applying a dummy electrolytic voltage between the cathode 184 and the anode 186 for dummy plating.

Please amend the paragraph on page 42, line 18, to line 28, as follows:

The loading plate 52 is returned to its original position. Next, the gripping mechanisms 108 of the transporter 42 grip two substrate holders 18 which now contain no substrate, at the same time, and return the substrate holders 18, to the prescribed position in the stocker 24, as described above. Subsequently, the gripping mechanisms 108 of the transporter 42 of the substrate holder transferring device 40 grip two of the substrate holders 18 holding the substrates that have been returned to the stocker 24 after the plating process, and transfers the substrate holders 18 onto the loading plate 52, as described above. The same process is repeated.

Please amend the paragraph on page 50, line 25, to page 51, line 11, as follows:

The plating unit 700 operates as follows: ~~The~~ the cylinder 714 is operated to lift the substrate holder 704 together with the guide member 710 by a predetermined distance, and the cylinder 722 is operated to lift the substrate presser 720 by a predetermined distance to a position where the

substrate presser plate 716 is located above the substrate takeout opening 706c. The substrate loading and unloading member such as a robot arm is then actuated to introduce the substrate W through the opening 706c into the space C in the substrate holder 704, and place the substrate W on the step such that the plating surface of the substrate W faces downward. The cylinder 722 is operated to lower the substrate presser plate 716 until its lower surface touches the upper surface of the substrate W, thereby sandwiching the outer circumferential edge of the substrate W between the substrate presser plate 716 and the step.

Please amend the paragraph on page 56, line 26, to page 57, line 4, as follows:

Further, in another embodiment, the substrate holding table 950 in the plating unit 900 may serve also as the side plate 912. In this case, the substrate holding table 950 which has received the substrate W from the substrate transferring device 904 can move to close the depression A of the plating tank body 911. The ~~other~~ remaining construction of the substrate holding table 950 is the same as in the above embodiment.